PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : B04C 9/00 — A1

(11) International Publication Number: WO 89/10795

(43) International Publication Date: 16 November 1989 (16.11.89)

(21) International Application Number: PCT/AU89/00186

(22) International Filing Date: 2 May 1989 (02.05.89)

(30) Priority data:
PI 8021 3 May 1988 (03.05.88) AU

(71) Applicant *(for all designated States except US)*: CONOCO SPECIALTY PRODUCTS INC. [US/US]; 600 North Dairy Ashford Road, Houston, TX 77252 (US).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : CARROLL, Noel [AU/AU]; "Strathalbyn", The Crescent, Sassafras, VIC 3787 (AU).

(74) Agents: SMEETON, Anthony, R. et al.; Davies & Collison, 1 Little Collins Street, Melbourne, VIC 3000 (AU).

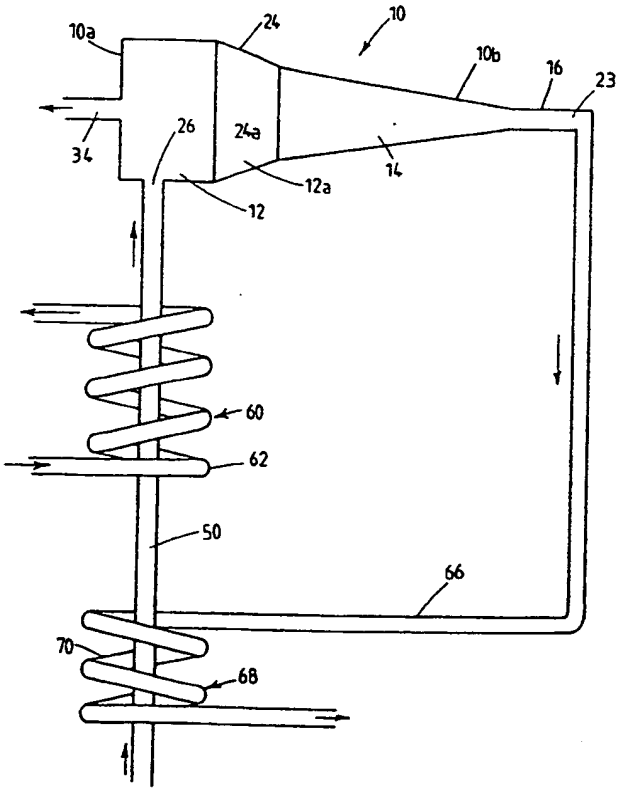
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CM (OAPI patent), DE, DE (European patent), DK, FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC, MG, ML (OAPI patent), MR (OAPI patent), MW, NL, NL (European patent), NO, RO, SD, SE, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.

(54) Title: CYCLONE SEPARATOR

(57) Abstract

A cyclone separator for separating a denser component of a liquid mixture from a less dense component thereof, the cyclone separator comprising at least one inlet (26) for the admission of material to be separated and outlets (23, 34) for the respective discharge of the denser and less dense components. An inlet duct (50) is provided by which the liquid mixture, in use, is transmitted into the separator via the or each inlet and there is further provided a heat exchanger (60) through which a heat exchanging fluid passes. The heat exchanger (60) is positioned adjacent the inlet duct (50) so as to effect heat exchange of the mixture passing through the inlet duct. One of the outlets (23, 34) may be operatively connected to the heat exchanger (60) or an auxiliary heat exchanger (68) so that fluid from this outlet passes through the heat exchanger.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
CF	Central African Republic
CG	Congo
CH	Switzerland
CM	Cameroon
DE	Germany, Federal Republic of
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
HU	Hungary
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
RO	Romania
SD	Sudan
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

"CYCLONE SEPARATOR"

This invention relates to cyclone separators for separating a denser component of liquid mixture from a less dense component thereof.

According to the present invention there is provided a cyclone separator for separating a denser component of a liquid mixture from a less dense component thereof, the cyclone separator comprising at least one inlet for the admission of material to be separated and outlets for the respective discharge of the denser and less dense components, an inlet duct by which the liquid mixture, in use, is transmitted into the separator via the or each said inlet characterized in that there is further provided a heat exchanger through which a heat exchanging fluid passes, said heat exchanger positioned adjacent said inlet duct so as to effect heat exchange of the mixture passing through said inlet duct.

In one preferred embodiment the cyclone separator comprises an axially extending separating chamber having towards one end the aforementioned inlet for admission of the mixture to the separating chamber, an axially positioned overflow outlet adjacent that one end defining one of the outlets. The separating chamber is of generally tapered form with a relatively larger cross-sectional size at the aforementioned one end and a relatively small cross sectional size at an axially positioned underflow outlet which defines the other of the outlets at the end of the separating chamber opposite the aforementioned one end. In use the denser component is directed to the underflow outlet in a fashion such as to encompass an inner axially positioned core of the less dense component which is subjected at least over a substantial part of its length to a pressure differential causing it to flow to the overflow outlet.

In one preferred embodiment, one of the outlets is operatively connected to the heat exchanger so that, in use, the separated component which flows from that one of the

outlets passes through the heat exchanger.

In another embodiment, one of the outlets is operatively connected to an auxiliary heat exchanger which is positioned adjacent the inlet duct so that, in use, the separated component which flows from that one of the outlets passes through the auxiliary heat exchanger.

Preferably the underflow outlet is operatively connected to the auxiliary heat exchanger. Furthermore, it is preferable that the heat exchanger and/or the auxiliary heat exchanger are adapted to heat the material in the inlet duct.

Preferably the auxiliary heat exchanger is disposed upstream of the first mentioned heat exchanger with respect to the inlet ducts.

A preferred embodiment of the invention is further described with reference to the accompanying drawing, the single figure of which is a diagram illustrating one form of the invention.

In the drawing, a cyclone separator 10 is shown as having an outer casing 24 of elongate somewhat cylindrical form, but tapering from a larger diameter end 10a to a smaller diameter end 10b. Casing 24 defines an interior separating chamber 24a which comprises a first generally cylindrical portion 12 of relatively large diameter connected to a second portion 14 of elongate tapered form via an intermediate flow smoothing tapered portion 12a, and a cylindrical portion 16 connected to the end of portion 14 opposite portion 12. A side inlet 26 is provided for inflow of material to be separated into the separator at the location of portion 12 and arranged so that material so inletted executes a rotational motion about the lengthwise axis of the separator. This rotational motion causes the more dense and less dense components of the inlet mixture to be separated, the more dense component moving lengthwise along the separating chamber to pass through the portions 12a, 14 and 16 and to emerge via an underflow outlet 23 adjacent end 10b of the separator. The less dense component emerges from the separating chamber 24a via an axial

overflow outlet 34 communicating with portion 12.

Material to be infed into the separator is passed thereinto via a duct 50. In order to aid separation of some materials, it is desirable that the material should be at an elevated temperature. Thus, a heat exchange 60 is shown as comprising a coil pipe 62 wound around the duct 50 and arranged for flow therethrough of suitable heated liquid whereby to impart, by heat exchange, a raised temperature to the material passing through duct 50.

In order, however, that the amount of heating required by use of heat exchanger 60 may be minimised, the separator 10 is arranged whereby one of the separated components from the separator is directed via a pipeline 66 to a further heat exchanger 68, such as in the form of the coiled pipe 70 shown as extending around duct 50.

In use, the material to be separated is passed through duct 50 and is first heated by residual heat exchange from the separated component in duct 66 which is directed through the heat exchange pipe 70. This effects partial heating. Then, the incoming material is further heated by use of the heat exchanger 60 before being directed into the separator 10. The separator 10 otherwise operates in conventional fashion.

It has been found that applying heat to oily water mixtures, for example, assists in separation of these. In such a case, the separator 10 may be constructed in accordance with the teachings of United States patent 4,237,006, 4,576,724 and 4,710,299. Another example of separator which may be used is PCT/AU85/00181. In such a case, the component which emerges from the underflow outlet 23 or passage through pipeline 66 to heat exchanger 68 will be predominantly water whilst that emerging from the outlet 34 will be predominantly oil. Separators of the kind discussed in these patent specifications are most suitable where there is a high proportion of water compared with oil, so that there will be a substantial flow through the outlet 23 as compared with the outlet 34. Thus, it is preferable that the residual heat be recovered and applied for heating

material in duct 50 be the liquid from the outlet 23 rather than from the outlet 34. However, it would of course be possible to alternatively arrange the separator so that it is the liquid from outlet 34 which is directed to the heat exchanger 68. Again, two heat exchanges may be provided so that material from both outlets can be directed to heat exchange for heating material in duct 50. Also, the described arrangement may be adapted for cooling of incoming material to be separated, by passing a coolant liquid at low temperature through heat exchanger 60.

CLAIMS

1. A cyclone separator for separating a denser component of a liquid mixture from a less dense component thereof, the cyclone separator comprising at least one inlet (26) for the admission of material to be separated and outlets (23, 34) for the respective discharge of the denser and less dense components, an inlet duct (50) by which the liquid mixture, in use, is transmitted into the separator via the or each said inlet (26) characterized in that there is further provided a heat exchanger (60, 68) through which a heat exchanging fluid passes, said heat exchanger (60, 68) positioned adjacent said inlet duct (50) so as to effect heat exchange of the mixture passing through said inlet duct.

2. A cyclone separator according to claim 1 characterized by an axially extending separating chamber (24a) having towards one end (10a) said inlet (26) for admission of the mixture to the separating chamber (24a) an axially positioned overflow outlet (34) adjacent said one end defining one of said outlets said separating chamber, being of generally tapered form with a relatively larger cross-sectional size at said one end (10a) and a relatively small cross sectional size at an axially positioned underflow outlet (23) defining the other of said outlets at the end of the separating chamber opposite said one end, (10a) wherein, in use, the denser component is directed to the underflow outlet in a fashion such as to encompass an inner axially positioned core of the less dense component which is subjected at least over a substantial part of its length to a pressure differential causing it to flow to the overflow outlet.

3. A cyclone separator according to claim 1 or claim 2 further characterized in that one of said outlets (23 34) is operatively connected to said heat exchanger (60, 68) so

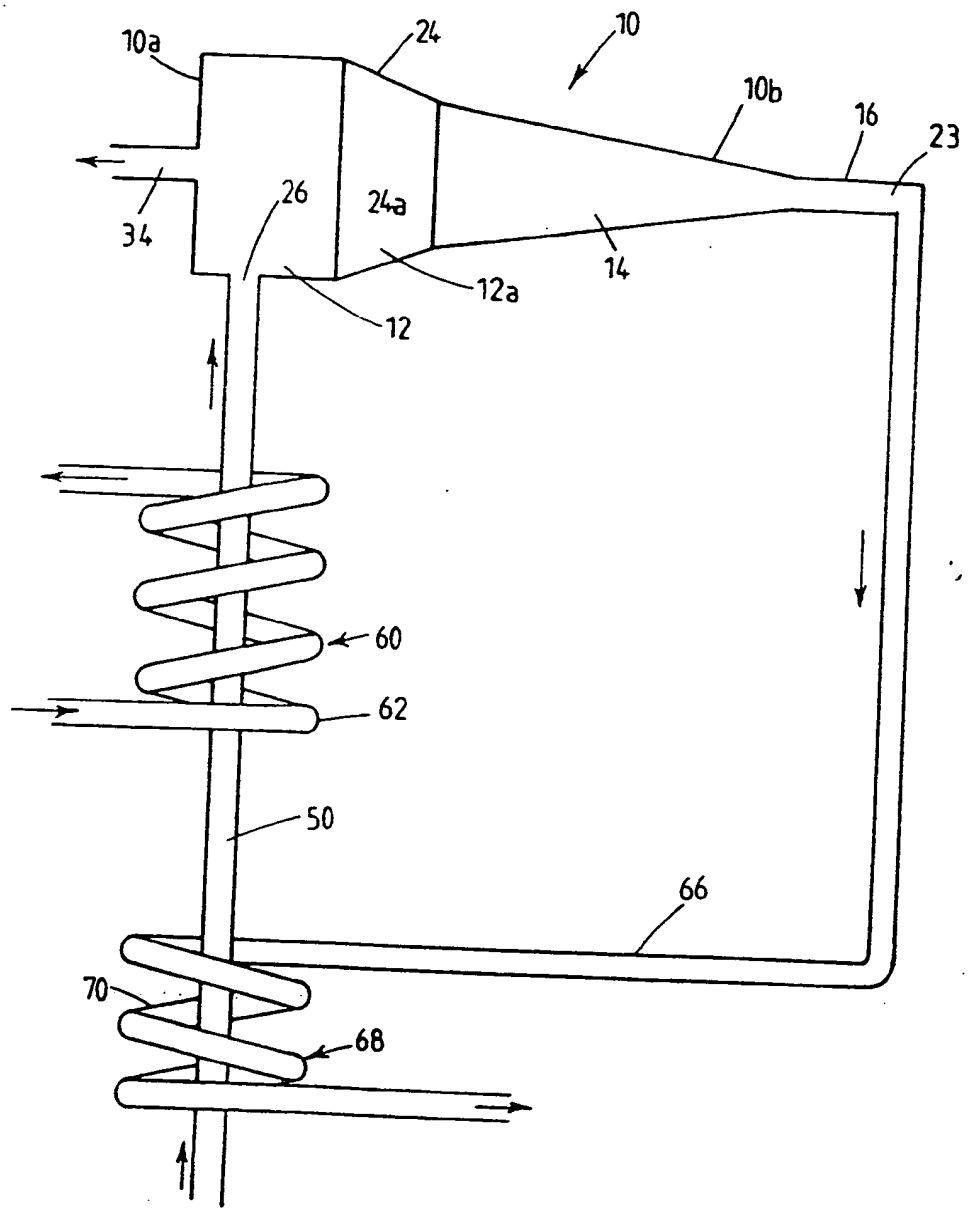
that, in use, the separated component which flows from said one of said outlets passes through said heat exchanger.

4. A cyclone separator according to claim 1 or claim 2 further characterized in that one of said outlets (23, 34) is operatively connected to an auxiliary heat exchanger (68) which is positioned adjacent said inlet duct so that, in use, the separated component which flows from said one of said outlets passes through said auxiliary heat exchanger.

5. A cyclone separator according to claim 4 characterized in that said underflow outlet (23) is operatively connected to said auxiliary heat exchanger (68).

6. A cyclone separator according to claim 4 or claim 5 further characterized in that said auxiliary heat exchanger (68) is disposed upstream of said heat exchanger (60) with respect to said inlet duct (50).

7. A cyclone separator according to any preceding claim wherein said heat exchanger or said auxiliary heat exchanger are adapted to heat the material in said inlet duct.


10a
24
10
10b
16
23
34
26
24a
14
12a
12
60
62
50
66
70
68

I. ERNATIONAL SEARCH REP(T

International Application No. PCT/AU 89/00186

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[4] B04C 9/00

II. FIELDS SEARCHED

Minimum Documentation Searched 7

Classification System	Classification Symbols
IPC	B04C 9/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

AU : IPC as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

Category*	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No 13
A	AU,A,46753/85 (VORTOIL) 27 February 1986 (27.02.86) Page 8 lines 18-22	
X	EP,A,140769 (CREUSOT-LOIRE) 8 May 1985 (08.05.85)	(1, 3-7)
X	GB.A.2155821 (DEUTSCHE BABCOCK WERKE) 2 October 1985 (02.10.85)	(1-7)
X	WO,A,87/05826 (EINCO OY) 8 October 1987 (08.10.87)	(1-7)
X	WO,A,86/03986 (AHLSTROM) 17 July 1986 (17.07.86)	(1-7)
A	Derwent Abstract Accession no 86-244476/37, Class P41, SU,A,1209260 (SIBE SIBTSVETMETNII) 7 February 1986 (07.02.86)	
X	Derwent Abstract Accession no 85-182401/30, Class P41, SU,A,1131539 (ZHDANOV METAL INST) 30 December 1984 (30.12.84)	(1-2)
X	Patents Abstracts of Japan, C-460, Page 60, JP,A,62-136218 (MITSUBISHI HEAVY IND LTD) 19 June 1987 (19.06.87)	(1-2)

* Special categories of cited documents: 10

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
3 August 1989 (03.08.89)	11 August 1989 (11.08.89)
International Searching Authority	Signature of Authorized Officer
Australian Patent Office	R.B. CAMPBELL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 89/00186

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Members		
AU 46753/85	BR 8507218 GB 2187401 WO 8601130	DK 1496/86 NL 8520221	FI 870434 US 4764287
EP 140769	FR 2555468		
GB 2155821	DE 3410143 US 4601734	DK 181/85 ZA 8500672	SE 8406605
WO 8705826	FI 861224	ZA 8702118	
WO 8603986	AU 53524/86 US 4747852	EP 245268	FI 850134

END OF ANNEX